TITLE OF THE INVENTION

Heat Radiator

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a heat radiator for radiating heat from a heating element such as a semiconductor element mounted in an electronic appliance such as a computer or the like.

2. Description of the Related Art

Japanese Laid-Open Patent Publication No. 2001-24372 discloses a conventional heat radiator, which is mounted in a notebook computer to radiate heat from a heating element in the computer.

As shown in Fig. 1, the heat radiator in the computer 50 includes a heat absorbing element 52 attached fast to a heating element 54 mounted in the computer 50, a pump 56 fluid connected to the heat absorbing element 52, and a heat radiating element 58 fluid connected to the heat absorbing element 52 and the pump 56, all connected in series to define a refrigerant circulating cycle. A typical refrigerant employed in this refrigerant circulating cycle is an easy-to-handle water-based one, and the pressure inside the refrigerant circulating cycle is relatively low of being approximately atmospheric pressure.

However, the heat radiator of the above-described construction is not suited to the use of a high-pressure refrigerant such as a fluorocarbon-based refrigerant, a latent heat effect of which is effectively utilized to further reduce the heat resistance to enhance the heat radiating performance. Because the pressure-resistant strength of the heat absorbing element 52 is not taken into consideration, it is likely that the use of the high-pressure refrigerant may deform the surface of the heat absorbing element 52 to which the heating element 54 is joined, giving rise to a possibility of lowering the heat radiating performance.

SUMMARY OF THE INVENTION

The present invention has been developed to overcome the above-described disadvantage.

It is accordingly an objective of the present invention to provide a heat radiator having a heat absorbing element suited to the use of a high-pressure refrigerant.

In accomplishing the above and other objectives, the heat radiator according to the present invention includes a heat absorbing element, a heat radiating element, and a pump connected with the heat absorbing element and the heat radiating element to define a closed circuit. A refrigerant filled in the closed circuit is circulated through the closed circuit by the pump. The heat absorbing element includes a heat-exchanging portion for transferring heat generated by a heating element to the refrigerant, a cover joined to a peripheral edge of the heat-exchanging portion to define a refrigerant flow channel therebetween, and at least one connecting member disposed within the refrigerant flow channel and having opposite ends joined to the heat-exchanging portion and the cover, respectively, to connect the heat-exchanging portion and the cover with each other.

The presence of the connecting member within the refrigerant flow channel reduces the surface areas of the heat-exchanging portion and the cover, to which the pressure of the high-pressure refrigerant flowing through the refrigerant flow channel is applied, and also reduces the load applied to such surface areas, thus preventing the surface of the heat-exchanging portion confronting the heating element from lowering in flatness.

The cover is joined to the heat-exchanging portion by melting a brazing filler material within a furnace. Although a high temperature inside the furnace reduces the strength of the heat absorbing element, the connecting member acts to

maintain the strength of the heat absorbing element above a predetermined level without deforming the surface of the heat absorbing element to which the heating element is joined.

BRIEF DESCRIPTION OF THE DRAWINGS

The above and other objectives and features of the present invention will become more apparent from the following description of a preferred embodiment thereof with reference to the accompanying drawings, throughout which like parts are designated by like reference numerals, and wherein:

Fig. 1 is a perspective view of a notebook computer having a conventional heat radiator mounted therein;

Fig. 2 is a circuit diagram of a heat radiator embodying the present invention;

Fig. 3A is a front elevational view, partly in section, of a heat absorbing element mounted in the heat radiator shown in Fig. 2; and

Fig. 3B is a section taken along line A-A in Fig. 3A.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

This application is based on an application No. 2003-277384 filed July 22, 2003 in Japan, the content of which is herein expressly incorporated by reference in its entirety.

Referring now to the drawings, there is shown in Fig. 2 a circuit diagram of a heat radiator R embodying the present invention. The heat radiator R shown in Fig. 2 includes a heat absorbing element 2, a heat radiating element 4, and a pump 6, all connected in series via piping 8 to define a closed circuit. A high-pressure refrigerant filled in this closed circuit circulates through the heat absorbing element 2, the heat radiating element 4, and the pump 6 in this order.

Fig. 3A depicts the heat absorbing element 2 partly in section, and Fig. 3B is a section taken along line A-A in Fig. 3A.

As shown in Fig. 3A, the heat absorbing element 2 confronts and is attached fast to a heating element 10 such as, for example, a semiconductor element mounted in an electronic appliance such as, for example, a computer. The heat absorbing element 2 receives heat Qin generated by the heating element 10 via a coating film 12 interposed between the heating element 10 and a heat-exchanging portion 14. The heat-exchanging portion 14 is made of a material having a high thermal conductivity such as, for example, copper, aluminum or the like. The heat Qin received by the heat absorbing element 2 is transmitted to the high-pressure refrigerant via the heat-exchanging portion 14. The high-pressure refrigerant so supplied with the heat Qin is carried into the heat radiating element 4, which is then cooled by a fan 16 juxtaposed therewith. As a result of cooling by the fan 16, the high-pressure refrigerant exhausts heat Qout to the open air. The high-pressure refrigerant having exhausted the heat Qout returns to the pump 6 again, thus forming a closed cycle.

A typical example of the high-pressure refrigerant is a fluorocarbon-based refrigerant known as R134. When this refrigerant is used in a heat radiator of the type referred to above, the refrigerant comes to range generally from 0℃ to 95℃. In this temperature range, a latent heat effect of the high-pressure refrigerant is utilized that is brought about by a change in phase between a liquid phase and a vapor phase of the refrigerant, making it possible to realize a high heat-exchanging performance during the heat absorbing and radiating processes and to reduce the heat resistance of the entire heat radiator R. Also, in the above temperature range, the refrigerant pressure becomes high enough to reach approximately 3MPa and, hence, the pressure-resistant strength of the heat radiator R is important.

The heat absorbing element 2 includes, in addition to the heat-exchanging portion 14, a cover 18 joined to a peripheral edge of the

heat-exchanging portion 14 to define a refrigerant flow channel 20 therebetween, an inlet tube 22 joined to the heat-exchanging portion 14, and an outlet tube 24 joined to the heat-exchanging portion 14 on the side opposite to the inlet tube 22. The refrigerant is introduced into the heat absorbing element 2 through the inlet tube 22 and discharged therefrom through the outlet tube 24. The cover 18 is joined to the heat-exchanging portion 14 by melting a brazing filler material within a furnace. Considering the properties of the brazing filler material, the temperature inside the furnace is required to reach approximately 900℃. Accordingly, if both the heat-exchanging portion 14 and the cover 18 are made of a like material such as copper or the like, the pressure-resistant strength of the heat absorbing element 2 considerably reduces, and it is likely that the use of the high-pressure refrigerant may deform the surface of the heat absorbing element 2 to which the heating element 10 is joined. If the flatness of such surface is not maintained, the thickness of the coating film 12 on which the thermal conduction depends increases partially, resulting in an increase in heat resistance.

In the practice of the present invention, the heat absorbing element 2 includes one or more (four in Fig. 3B) connecting members 26 disposed within the refrigerant flow channel 20 and having opposite ends joined to the heat-exchanging portion 14 and the cover 18, respectively, to connect them. Because the connecting members 26 receive the pressure of the refrigerant inside the refrigerant flow channel 20, the pressure applied to the opposing surfaces of the heat-exchanging portion 14 and the cover 18 that are exposed to the refrigerant flow channel 20 reduces, enhancing the bending strength of the heat-exchanging portion 14 and preventing the surface of the heat-exchanging portion 14 confronting the heating element 10 from lowering in flatness.

Although the present invention has been fully described by way of examples with reference to the accompanying drawings, it is to be noted here that

various changes and modifications will be apparent to those skilled in the art. Therefore, unless such changes and modifications otherwise depart from the spirit and scope of the present invention, they should be construed as being included therein.